degree according to the material used, on the upper and lower limits between which, since the last complete release from tension, the tensions have varied (the *succession* alone, not the *time*, being here determinant). In a thermo-element of two similar wires, stretched with equal weights, but of which one (*a*) has last borne a greater, the other (*b*) a less weight, the current flows from *b* to *a*. In iron and steel the previous tensions even affect the direction in which the thermo-current varies with increasing or decreasing tension. Taking the direction of the current which arises with the *first* weak stretching, it is opposite for hard and soft wires, and the discordance above referred to is thus explained. Herr Cohn thus formulates his general conclusion: "A stretched wire behaves, *ceteris paribus*, differently, according as it has before been stretched more weakly or more strongly, and this difference continues till the next alteration of the tension."—Herr R. Weber contributes a useful paper on the chemical composition of glasses with relation to their resistance to atmospheric influences. He finds that the composition of many well tested lime alkali glasses approximates the proportions $6SiO_2$, $1CaO$, and $1K_2O$ or Na_2O; but also, in good glasses, there may be more alkali, if it be compensated with more than 6 equivalents of silicic acid; and less silicic acid may be allowed if the lime be diminished relatively to the alkali.—The transmission of high tones through the telephone is discussed by Herr Hagenbach. From his experiments it appears that the (upper) limit of audibility with the instrument is commonly about two octaves lower than in direct hearing. The cause is found not in the line, nor in the magnet, but in the plate, which, when the variations of magnetism exceed a certain number per second, no longer keeps up with them.—Herr Aron gives a mathematical study of the microphone; *inter alia*, it is shown that, whereas in the telephone the "clang tint" is exalted, in the microphone it is lowered.—Herr Herwig prosecutes his study of liquid cells as condensers; considering the charge of cells, first by large constant batteries, then by small forces (both acting shortly), and comparing the full charges in cells containing liquids of different resistances.—We further note a new hygrometer by Herr Edelmann, based on the fact that if any space be filled with atmospheric air, and the aqueous vapour then removed, without altering the volume, the pressure decreases by the amount of tension of this vapour. A sinus manometer for measuring small differences of air-pressure (Thomsen), and a simple regulator for the electric light (Stöhrer) are also described.—Herr Fröhlich shows the bearing of the principle of conservation of energy on the theory of diffraction.

THE *Rivista Scientifico-Industriale*, (1879, No. 7) contains the following papers of interest:—On some prehistoric discoveries in Sicily, by Prof. Francesco Mangini.—On the lengthening of filiform conductors traversed by an electric current, by Prof. G. Basso.—On the optic rotatory power of quartz and its variation with temperature, by M. Joubert.—On digallic acid, by Prof. U. Schiff.—On some phenomena due to the viscosity of liquids, by Prof. Carlo Marangoni.—On Sargasso seas, by the same.—On Helmholtz' double siren, by the editor.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 20 and 27, and April 3.—"On the Reversal of the Lines of Metallic Vapours," Nos. iv., v., and vi., by Professors Liveing and Dewar.

In the first of these experiments the metals were produced by chemical reactions within the tubes, used as before described. They found that cæsium chloride alone heated in glass tubes gave no absorption lines, but cæsium and rubidium chlorides when heated with metallic lithium each showed its characteristic absorption lines. Charred tartrate of cæsium heated in a furnace in a narrow porcelain tube gave very readily the two lines in the blue reversed, and charred rubidium tartrate the two violet lines reversed, but no reversal in any other part of the spectrum. When charred potassium tartrate was treated in the same way, a broad absorption band was seen extending from wave-length about 5,700 to about 5,775. This band was also seen for a short time bright, when the material was put into the tube before it was heated, and the light observed as the tube got hot. It was also seen bright in the induction-spark taken between platinum and potassium in carbonic oxide. Besides this band the vapours from the charred potassium tartrate produced another absorption band in the red, and two more in the blue. None of these absorptions correspond with those seen when potassium is heated in hydrogen, or with known emission lines of that metal, though the first and most conspicuous is near a well-known group of three bright lines of potassium. Charred sugar mixed with carbonate of soda gave only the same absorption as sodium in hydrogen. A mixture of barium carbonate, lamp-black, and aluminium filings gave dark bands corresponding to the bright bands seen when sparks are taken from a solution of barium chloride marked *α*, *β*, and *δ* respectively by Boisbaudran; and at the highest temperature of the furnace fed with Welsh coal a mixture of charred barium tartrate and aluminium gave the barium line wave-length 5535 sharply reversed. Charred strontium and calcium tartrates with aluminium gave no reversals, but with the addition of sodium or potassium carbonate the well-known blue line of strontium and violet line of calcium were reversed. The temperature at which these results were obtained was reached by the use of gas retort carbon as fuel, and was such that iron tubes well coated with fire-clay gave way in a few minutes.

The next experiments were made with tubes bored out of lime and heated at the bottom by a jet of coal-gas and oxygen introduced through a lateral opening. In these, as in the previous experiments, the hot bottom of the tube itself (not an independent light as used by Messrs. Lockyer and Roberts in their experiments with lime tubes) gave the luminous background. In this way the violet line of calcium was reversed, the red line of lithium and the orange and green bands of lime appeared with dark lines down their middles.

A larger series of experiments was made with similar tubes of lime, but with an electric arc introduced through lateral openings as the source of light and heat. In some cases a tube bored in a block of gas carbon was employed, and was then made one of the electrodes. The carbon tubes, however, were found to conduct away the heat, and though they lasted much longer, did not in general succeed so well as the lime tubes. In same cases aluminium was used as a reducing agent, and in others more volatile substances, viz., potassium and sodium carbonates, were used to increase the amount of vapour carried up into the tube; and in others a current of hydrogen was introduced.

Of the calcium lines the violet line (4226) was almost always seen expanded with a dark middle, and the three brightest lines in the indigo were often in a similar condition. The addition of aluminium generally made them appear as dark bands on a continuous background. Of the two Fraunhofer lines H, the more refrangible (K) was the first to appear reversed, and remained so the longer. Other calcium lines reversed were, one in the green (5188), and, much less easily, two in the red (6161, 6121), one more in the indigo (4302), and one in the blue (4877).

In the case of strontium, the well-known blue line was easily reversed, and two lines in the violet (4215, 4077), less easily five lines in the blue (4812, 4831, 4868, 4873, 4895), and, by the aid of aluminium, one in the green (4962). In the case of barium, besides the persistent ray 5535, two other lines in the green (5518, 4933), a line in the blue (4553), and one in the orange (6496), were reversed.

With magnesium the *b* group were expanded and reversed in an order the inverse of their refrangibility. The other lines of that metal were expanded, but not reversed, and the blue line, 4481, conspicuous in the spark between magnesium electrodes, was not seen at all. This line does not appear in Capron's photographs of magnesium in arc. An attempt to re-introduce it by combining the action of an induction spark with that of the arc in a lime tube failed owing to the conducting power of the hot gases and walls of the tube, and will probably only succeed with a pressure of several atmospheres in the apparatus. The similar disappearance of the cadmium lines 5377 and 5336 was also noticed.

In using potassium carbonate the two extreme pairs of lines, in the violet and red respectively, were readily reversed; less readily the three lines in the greenish-yellow, other two lines in the red (6913, 6946), a group of three in the orange (5353, 5338, 5322), and the least refrangible (5112) of another triplet in the green.

Using sodium chloride, the pair of lines next more refrangible than D were repeatedly reversed, the less refrangible being the first and most strongly reversed, as has also been observed by Mr. Lockyer. A second pair of bright lines usually came out at the same time, like ghosts of the first, on the more refrangible side.

With lithium chloride, the red and blue lines were easily re-

versed, the orange line well reversed, and the green, though with difficulty, distinctly reversed; the violet line, much expanded, showed no reversal. The authors conclude that the green line really belongs to lithium, and not to cæsium, since the blue lines of the latter metal, so easily reversed, never appeared.

In the case of rubidium, the more refrangible of the red lines was seen as a black line on a continuous background, but this background of light did not extend so low as to allow the reversal of the extreme ray of rubidium to be observed.

With metallic indium the two characteristic lines were seen strongly reversed, but no other; metallic gallium also gave its two characteristic lines reversed, the more refrangible being the less strongly so.

Aluminium gave no reversal of any of its lines, except the two between the Fraunhofer lines H. It was noticed that the addition of aluminium to either copper or silver in the lime tubes caused the copper or silver lines, previously predominant, to fade, while the calcium lines came out instead with marked brilliance.

Reviewing the series of reversals which they have observed, the authors remark that in many cases the least refrangible of two lines near together is the most easily reversed, as has been previously remarked by Cornu. Thus, in the case of barium (though there is no very distinct grouping of the lines of that metal), taking the rays in order, the line wave-length 5535 is readily reversed, while that with wave-length 5518 is less easily reversed; the line wave-length 4933 is comparatively easily reversed, whereas that with wave-length 4899 has not been reversed. On the other hand, the line wave-length 4553 has been reversed, but not the line wave-length 4524. In the case of strontium, the lines wave-length 4831 and 4812 have been reversed, but not the line wave-length 4784, and the two lines wave-length 4741 and 4721 remain both unreversed. In the group of five lines of calcium, wave-length 4318 to 4282, it is only the middle line wave-length 4302 which has been reversed. Of the potassium groups of lines wave-length 5829 and 5811, 5802, 5782, the line wave-length 5811 has not been reversed, and of the others the line wave-length 5802 is the first to appear reversed. It is worthy of remark that the first of these lines is faint and the last is the brightest of the group. The group wave-length 5353, 5338, 5322 have been all reversed, but the last of the three (5322) was the most difficult to reverse: it is also the feeblest of the group. In the more refrangible group, wave-length 5112, 5092, 5078, the least refrangible is the only one reversed.

Making a general summary of their results respecting the alkaline earth metals, potassium and sodium, and having regard only to the most characteristic rays, which for barium they reckon as 21 in number, for strontium 34, for calcium 37, for potassium 31, and for sodium 12, the reversals in their experiments number respectively 6, 10, 11, 13, and 4. That is in the case of the alkaline earth metals about one-third, and these chiefly in the more refrangible third of the visible spectrum; the number of characteristic rays remaining unreversed in the more refrangible part of the spectrum being respectively 2, 5, and 4. In the case of potassium they reversed two in the upper third, all the rest in the least refrangible third. These experiments relate to mixtures of salts of these metals combined with the action of reducing agents.

In a table the authors show the relation between their observations on reversals and Young's on the chromospheric lines.

The authors point out that in Young's catalogue the green coronal line (wave-length 5316) is almost as frequently present in the chromosphere as the lines numbered 1 and 82, and D_3 which he suggested might belong to one substance, and they think that the four lines may all belong to the same substance; and they call attention to certain analogies in the ratios of the wave-lengths of these four lines to those of the lines of hydrogen, lithium, and magnesium.

April 24.—"On the Nature of the Fur on the Tongue," by Henry Trentham Butlin, F.R.C.S.

Tongue-fur consists chiefly of (1) *Débris* of food and bubbles of mucus and saliva. (2) Epithelium. (3) Masses which appear at first to consist of granular matter, but which are the glœa of certain forms of schistomycetes. That the last-named of these three is the essential constituent is proved by the fact that the quantitity of the glœa corresponds roughly with the quantity of fur present, and that its position upon the tongue corresponds exactly with that of the fur, both covering the tops of the filiform papillæ, but not usually lying between them.

In order to ascertain the true nature of the glœa, and to obtain it in a purer form, it was cultivated upon a warm stage. Several fungi were discovered, but only two of these were present in every instance, *Micrococcus* and *Bacillus subtilis*; and, as the glœa produced artificially was similar to that existing naturally in the tongue-fur, it is believed that fur is composed essentially of these two fungi. *Micrococcus* developed freely and abundantly, forming large masses of yellow or brownish-yellow colour. *Bacillus* did not develop, but existed in greater or less abundance in all the cases examined. Its development was probably prevented by the presence of other developing organisms, from which it was found impossible to separate it. It appeared to be identical with the *Leptothrix buccalis* of Robin. Although it did not develop under artificial conditions, it is probable that development takes place freely upon the surface of the tongue. Its habitual occurrence there, and the presence of spore-bearing filaments favour this view.

Besides these fungi there were present, more or less constantly, *Bacterium termo*, *Sarcina ventriculi*, *Spirochæta plicatilis*, and a larger form of *Spirillum* (or rather *Vibrio*). *Sarcina ventriculi* was frequently present, and generally developed quickly, forming large masses of a yellow or yellowish-brown colour. *Spirochæta plicatilis* occurred only in two or three of the specimens examined. *Bacterium termo* existed in some of the furs, and twice developed with such rapidity that the whole of the fluid was crowded with these organisms.

The slime between and around the teeth was found to consist of the same fungi as the tongue-fur, but the rods of Bacillus were longer, probably owing to the disturbing causes being fewer.

Physical Society, April 26.—Prof. W. G. Adams in the chair.—Mr. C. V. Boys gave an account of some experiments made by Dr. Guthrie and himself on the subject of Arago's rotation. The experiments were begun with a view to determine if the drag on a copper disk when a magnet is made to revolve beneath it, or on the magnet if the disk is made to revolve above it, could be made use of for determining the velocity of running machinery. They made the magnet revolve, and obtained the angle of deflection of a disk suspended by a torsion thread (the hair-spring of a watch). They found, as Snow, Harris, and others found before, that other things being equal, the drag is directly proportional to the speed, so that if the torsion of the thread could be relied on, and the strength of the magnet did not change, a perfect velocimeter could be constructed. They consider that this method is better than observing the deflection of a magnet over a revolving disk, as in this case they are limited to less than a right angle, and changes in the absolute magnetism of the earth would affect the results. They also determined the effect of change of distance, thickness, diameter, and nature of the disk, &c., their results agreeing with those of former experiments. They observed that the effect of concentric circular cuts was far greater than that of even many radial cuts, and that when radial sectors were entirely separated from each other, the effect was much less than when these were united at the centre. They then experimented on liquids by suspending a sphere or cylinder of the liquid between the poles of a revolving electromagnet, and succeeded in getting a decided and measurable effect. The importance of this is very great, for they have thus a means of determining the conductivity of liquid electrolytes by currents induced in the liquid without the use of electrodes, and without polarisation.—Dr. Guthrie stated that as the push on the liquid is directly proportional to the current quantity, they hope to measure the conductivities of liquids, and connect these to the conductivity of solids through the intervention of mercury. In reply to Prof. Adams Mr. Boys said that the angle of deflection of the conductor had proved to be proportional to its conductivity. Dr. O. J. Lodge suggested that the conductivity of the disks used in these experiments should be determined by plotting out the equipotential surfaces. Dr. Sylvanus Thomson recommended trying conducting jellies in these experiments, and Dr. Guthrie replied that such were being prepared for trial, including the permanent jelly made by dissolving gelatine in anhydrous glycerine at 100°.—Prof. Sylvanus Thomson then communicated five laboratory notes from University College, Bristol. The first related to the source of sound in the Bell telephone receiver. Two theories are now being discussed as to this effect, the molar theory regards the motion of the diaphragm-mass as the source of sound, the molecular theory finds it in the molecular motions of the mag-

netic core of the instrument. Prof. Thomson applied his method of getting magnetic curves with iron filings dusted on gummed glass to this problem. He found that when no currents passed in the telephone the magnetic lines springing from the pole of the magnet are gathered together on the diaphragm opposite over a central region, which is magnetised lamellarly or like a magnetic shell. The rim of the plate beyond this region is, however, magnetised radially, and between these two zones there is a neutral circle. It was remarkable too that the lines of force touching the plate were bent back around this circle, forming a kind of valley. When the current passed in the coil, in a direction so as to reinforce the magnetism, the lines are gathered more closely on the central region of the plate. If the current diminishes the magnetism the lines are, on the other hand, repelled from the plate. The neutral ring is also altered. In the first case it shrinks in size, in the second it expands. A small thick disk is wholly magnetised lamellarly; a disk entirely magnetised radially becomes slightly conical in shape. In the actual telephone the disk is flat at the middle and conical at the edges. As the current varies the diaphragm will assume new nodal lines. Dr. Thompson concludes that the molecular theory is not therefore necessary to account for the speech of the telephone, although it may assist. As confirming this view, he found that with iron rings round a cardboard diaphragm, and an iron centre-piece, the enunciation was good, though the timbre was altered, whereas with radial pieces of iron on the cardboard, the timbre was good but the enunciation bad. In reply to Prof. Adams, Dr. Thompson said that the stronger the magnet the shorter the lamellarly magnetised space became, and that with a thicker disk the neutral ring was not so well marked. Dr. Lodge suggested that the best place for the coil would be in the valley over the neutral ring, which was in an unstable condition. Dr. Thompson next wrote on a saw-blade with a magnet and dusted iron filings on it, which arranged themselves so as to trace the writing. This is usually shown on a steel plate, but a saw retains the virtue for six or eight months. A modification of this experiment, due to himself, consisted in writing on the blade with one pole of a powerful battery, the other pole being connected to the end of the blade. The third "note" recommended the use of fine steel fibres, got by breaking iron gauze of 32 meshes to the inch, instead of iron filings, for exhibiting magnetic lines. The fourth note showed that the lines of force got by filings fixed on cards are magnetic, that of a bar-magnet acting as a magnet. The fifth note explained that solid magnetic "figures" could be got by coating iron filings in shellac to make them light, and floating them in water; or by mixing filings in a soft paste of plaster of Paris, which could be cut into sections on hardening.

Chemical Society, May 1.—Dr. Warren de la Rue, president, in the chair.—The following papers were read:—On the volumes of liquids at their boiling-points obtainable from unit volumes of their gases, by Dr. W. Ramsay. The author has suggested the use of a thin glass bulb filled with the liquid, and heated in its own vapour until expansion ceases, the bulb is then allowed to cool, and is weighed; thus the volumes of many liquids at their boiling-points, "ebullition volumes," has been determined by the author. His results agree closely with those obtained by Kopp; the time required for a determination is half an hour.—On a method of precipitating manganese as dioxide, and its application to the volumetric determination of manganese, by J. Pattinson. Manganese in solution can be completely precipitated as dioxide by bleaching-powder solution or bromine water, if an equal quantity of iron, as ferric chloride, be present. The dioxide is then dissolved in dilute sulphuric acid, reduced by standard ferrous sulphate and titrated with bichromate.—On the determination of nitric acid as nitric oxide by means of its action on mercury, by R. Warington. In this well-known process of Crum and Frankland the author has found that the removal of the chlorides is unnecessary, and that small quantities of organic matter, except cane sugar, do not interfere with the results.—On a new class of colouring-matters, by Dr. O. N. Witt. By oxidising a mixture of metatoluylene diamine and dimethylparaphenylendiamin in aqueous solution, the author has obtained several new colouring-matters, toluylen blue, violet, pink, &c.

Institution of Civil Engineers, April 29.—Mr. Bateman, F.R.S., president, in the chair.—The first paper read was on street carriageway pavements, by Mr. George F. Deacon, M.Inst. C.E.—The second paper read was on wood as a paving material under heavy traffic, by Mr. O. H. Howorth, Assoc. Inst. C.E.

EDINBURGH

Royal Society, April 21.—On the anatomy of the northern Beluga (*B. catodon*) compared with that of other whales, by Morrison Watson, M.D., and Alfred H. Young, M.B., of the Owens College, Manchester.—This paper contains a complete account of the visceral anatomy of *Beluga*. In connection with the larynx, the existence of pouches similar to those previously described by Murie in Risso's Grampus is pointed out. These pouches undoubtedly correspond to the large laryngeal air-sac of the whalebone whales; both are regarded by the authors as homologous with the ventricles of Morgagni of other mammals, and not, as considered by previous anatomists, with the well-marked air-sacs met with in several species of quadrumana.

BOSTON, U.S.A.

American Academy of Arts and Sciences, April 9.—Hon. Charles Francis Adams in the chair.—Prof. Benjamin Peirce presented a paper on the meteoric constitution of the solar system, in which the existence of a meteoric shell outside of the planetary system is maintained. The meteors, in falling from this shell, would be subject only to the attractions of the sun and planets. The motions of the larger meteors or comets were discussed, and some remarkable agreements of observed facts with the theory were shown.—Prof. Pickering described a new form of transit instrument for measuring the light of the stars. Much of the time spent when using other photometers in identifying the object is thus saved. The stars are compared directly with the pole-star, and the variations of an artificial star are thus avoided. At the Harvard College Observatory the measurement of the light of about 4,000 stars of the sixth magnitude and highest, has been undertaken with this instrument. Each star will be observed on three nights, and two sittings will be made each evening.—A paper on the action of bromine on substituted toluols was presented by Prof. C. Loring Jackson and Mr. A. W. Fields.—Mr. W. W. Jacques, of Johns Hopkins University, Baltimore, presented the results of an investigation into the distribution of heat in the spectra of various sources of radiation. The distribution of heat in the spectrum of a solid or liquid source of radiation was found to be nearly independent of the temperature of the source. Dr. Draper's conclusion that "It necessarily follows that in the spectrum any two equivalent series of undulations will have the same heating power, no matter what their actual wave-length may be," was found to be not correct.

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